TITLE

The Effect of Attentional Focus Instructions on Performance and Technique in a Complex Open Skill

AUTHOR

Bull, Hamish G.; Atack, Alexandra C.; North, Jamie S.; et al.

JOURNAL

European Journal of Sport Science

DATE DEPOSITED

18 January 2023

This version available at

https://research.stmarys.ac.uk/id/eprint/5707/

The Effect of Attentional Focus Instructions on Performance and Technique in a Complex Open Skill

Abstract

External focus of attention has been shown to promote more automatic motor control, yielding better performance and more efficient technique, than an internal focus (Wulf, 2013). However, most research has used closed-skill tasks in novices. The extent to which the reported pattern of findings generalises to more complex, time-constrained tasks requires further investigation. In this study we investigated the effect of attentional focus instructions on performance and technique in an open-skill task in skilled performers. Thirteen skilled cricket batters batted from a ball projector in four conditions, receiving instructions to focus on the movement of their hands (internal focus), the movement of their bat (proximal external focus), the flight of the ball (distal external focus), or no instruction (control). Performance and technique were measured by quality of bat-ball contacts and step length/knee flexion, respectively, whilst playing straight drives. Compared to external focus and control conditions, focusing internally yielded significantly worse batting performance and shorter step lengths, with the largest effects observed between internal and distal external focus conditions. Quality of bat-ball contact data suggested that participants' ability to protect the wicket (as evidenced by more miss/edge shots) was more negatively affected by focusing internally than their ability to play shots to score runs (as evidenced by fewer good bat-ball contacts). Findings suggest that, for skilled performance of open-skill tasks, a distal external focus yields more effective performance and technique compared with focusing internally. Findings highlight the need for further research on attentional focus effects between different skills within specific sports.

Highlights

- A distal external focus of attention enhances performance and technique of skilled cricket batters compared with an internal focus.
- Providing skilled batters with no instructions yields similar performance benefits to distal external focus instructions.
- Focusing internally differentially negatively affects skilled cricket batters depending on the strategic intention of the shot being played (e.g., protecting the wicket vs attempting to score runs).

Keywords: Motor Control, Focus of Attention, Sports Performance, Kinematics, Cricket

The Effect of Attentional Focus Instructions on Performance and Technique in a Complex Open Skill

In complex and time-constrained tasks like cricket batting, the focus of attention that performers adopt affects skilled motor performance (Chua et al., 2021; Gray, 2004; Wulf, 2013). An internal focus of attention on the production of actions has been shown to result in performance breakdown in skilled performers, for whom these skills have been largely automatized through experience and practice (Beilock et al., 2002), whereas focusing attention externally on the effect of the movement or action outcome has typically been reported to result in superior performance (Becker & Fairbrother, 2019; Porter et al., 2013). It is important, therefore, that coaches exercise caution when providing instructions, particularly given the prevalence of stressors such as competitive performance anxiety, which can direct athletes' attention towards movement production (Halperin et al., 2016; Masters & Maxwell, 2008). Although an extensive body of research exists which has investigated the effect of different attentional focus instructions in closed-skill tasks (e.g., darts, Becker & Fairbrother, 2019; golf putting, Beilock et al., 2002), less is known about how such instructions affect the performance of open skills, particularly in skilled performers. Therefore, we investigated how attentional focus instructions designed to manipulate attentional focus affected skilled athletes' performance of a complex, open skill.

To explain the finding that tasks are typically performed more effectively under an external focus of attention than when an internal focus of attention is adopted, Wulf et al. (2001) proposed the Constrained Action Hypothesis. The theory suggests that focusing internally leads to conscious control of movements and constrains the motor system by interfering with otherwise automatic processes. In contrast, focusing externally is proposed to promote more automatic motor control. Consistent with this, researchers have demonstrated greater automaticity when focusing externally than internally via lower probe reaction times, higher frequency of movement adjustments, and reduced pre-movement times (Lohse, 2012; Wulf et al., 2001). Also consistent with the notion that an external focus leads to reduced attentional demands, the Conscious Processing Hypothesis (Maxwell & Masters, 2002; Poolton et al., 2006) suggests that when focusing internally, working memory is overloaded due to attending to *both* internal cues and external goal-relevant factors such as the action outcome. In contrast, when focusing externally, the athlete only needs to attend to one external information source. This is supported by research demonstrating better performance when focusing externally than internally under dual-task conditions (Sherwood et al., 2020).

Rather than superior performance being evident when the performer merely focuses on any external cue, research highlights the need to direct attention to the movement/action effect or task goal (Wulf, 2013). For example, Castaneda and Gray (2007) demonstrated that error was reduced when skilled baseball batters focused on the ball flight after contact (an action effect resulting from moving the body to swing the bat) compared with focusing on a secondary task (judging the frequency of an auditory tone: although external, the focus here is unrelated to skill execution). Similarly, when researchers have manipulated the distance of external focus through instructions, a distal external focus (further from the performer) has been shown to be more beneficial than a proximal one (closer to the performer) for skilled athletes (Singh & Wulf, 2020). Bell and Hardy (2009) demonstrated that skilled golfers were more accurate when employing a distal external focus (on the ball flight) than a proximal external focus (on the movement of the club head), both of which yielded better performance than an internal focus (on the movement of the wrists). Focusing on more distal action effects was suggested to be inherently more distinguishable from the athlete's body movements

(Bell & Hardy, 2009). Moreover, when focusing on ball flight, the skilled golfers would have attended to what occurs *after* the movement was produced, rather than during, which may have reduced the extent to which they could attend to the production of the movement itself (see Wulf et al., 2000). Cumulatively, these findings suggest that directing attention to action effects facilitates the high degree of automaticity that is characteristic of skilled performance.

While attentional focus effects are widely documented, most studies have involved novice participants completing closed-skill tasks, with open-skills of skilled athletes seldom studied (Wulf, 2013). Compared to closed skills, open-skills are characterised by greater movement complexity, increased environmental information, and time-sensitive decision-making processes (McNevin et al., 2003; Runswick et al., 2018). Some of the only research investigating how different attentional foci affect performance of open skills by skilled performers has been conducted by Gray and colleagues (Castaneda & Gray, 2007; Gray, 2004). Castaneda and Gray (2007) used a simulated baseball batting task in which skilled batters were simultaneously required to make judgements about the direction their hands, the bat (both pre-contact), or the ball (post-contact) were moving, reflecting an internal, proximal, and distal external focus, respectively. Consistent with findings from closed-skill tasks, when focusing internally, performance was worse than when adopting a proximal external focus of attention, which yielded worse performance than a distal external focus. While this provides an insight into attentional focus effects in open skills, the method employed may lack practical utility. An auditory tone was used to ensure participants attended to what was intended. However, verbal instructions are the primary mode of information provision that sports coaches use (Ford et al., 2010; Partington & Cushion, 2013). It is therefore important to investigate how specific instructions designed to differentially direct athletes' attention affect performance of open skills in skilled performers.

Because poor skill execution does not necessarily lead to poor performance, assessing technique provides a supplementary and more direct assessment of the effect that instructions have (Gray, 2011). Researchers have increasingly evaluated *both* performance and movement effects, with an external focus of attention resulting in better technique and greater movement efficiency (e.g., Bell & Hardy, 2009). In a dart throwing task, Lohse et al. (2010) demonstrated that focusing internally resulted in reduced muscular coordination and efficiency whilst increasing muscle co-contractions and stiffness, ultimately reducing throwing accuracy (see also Hitchcock & Sherwood, 2018). Again, except for Gray (2004), attentional focus effects on movement technique have largely been demonstrated in closed-skill tasks. Gray (2004) compared performance and movement kinematics of skilled baseball batters whilst performing a dual task (tone counting), focusing on the movement of their bat, or in a control condition. When focusing on the bat, skilled batters appeared to consciously control skill production, as performance was degraded, and higher movement variability observed. While these findings provide insight into how attentional focus affects technique in open-skill tasks, to better inform coaching practice, a fuller investigation that compares the effect of instructions differing in proximity on performance and technique is needed.

In this study we investigated the effect of attentional focus instructions on cricket batting performance and technique. We compared quality of bat-ball contacts, step length and knee angle of skilled cricket batters when given instructions to focus on the flight of the ball (distal external focus), the movement of their bat (proximal external focus) or the movement of their hands (internal focus). A no-instruction control condition was also employed. Both kinematic variables have been reported in the limited field of batting biomechanics. Greater knee flexion is thought to lower centre of mass, improving balance during bat-ball contact. Increased stride length, if timed appropriately, promotes forward movement of the batter's centre of mass just before impact and might therefore be indicative of more desirable movement patterns (Stretch et al., 1998; Stuelcken et al., 2005). We hypothesised, based on previous research (e.g., Bell & Hardy, 2009; Castaneda & Gray, 2007), that a distal external focus would yield the best batting performance, compared to a proximal external focus, which we further expected to yield better performance than focusing internally. We further hypothesised that an internal focus would result in the shortest step lengths and most extended knee angles, whereas a distal external focus would yield the longest step lengths and most flexed knee angles, the rationale being that focusing internally has been shown to lead to longer reaction times and greater muscular co-contractions and stiffness (Lohse et al., 2010; Vance et al., 2004).

Methods

Participants

An a-priori power calculation was conducted using G*Power 3.1 (Faul et al., 2007), indicating a required sample size of 10 participants. Because previous research comparing attentional focus effects in skilled performers across more than two experimental conditions has tended to yield large effect sizes (e.g., Bell & Hardy, 2009; Porter et al., 2013), we calculated a sample size that could detect a large effect size (f = .40), with an alpha level of .05 and a power of .80. Thirteen skilled male batters (35.5 ± 12.0 years) participated in the study (11 right-handed and two left-handed). Participants had 22.7 ± 10.1 years' cricket playing experience. All participants had experience playing in Division 1 of the Four Counties Cricket League with four having represented their county. Ethical approval was granted by the University's ethics committee and all participants provided written informed consent.

Apparatus / Set up

The experiment took place in outdoor cricket nets. All shots were recorded via two cameras (Panasonic HC-V720 HD camcorder, Panasonic UK Ltd., Berkshire, UK; 50 Hz). Camera A (lens 1.3 m off the ground) was positioned outside the net, behind the bowling machine, to determine bat-ball contact. Camera B (lens 0.8 m off the ground) was situated perpendicular to the batter and calibrated to record movements in the sagittal plane for biomechanical analysis (see Figure 1). A frame rate of 50 Hz was deemed sufficient to determine the bat-ball contact frame and front knee kinematics accurately due to the minimal motion observed (mean change of 2° in front knee angle from heel strike to ball contact; Stuelcken et al., 2005). The bowling machine (2016 BOLA bowling machine, Bola Manufacturing Ltd., Bristol, UK) was placed with the nose of the machine just behind the bowler's crease, angled into the batter's 'off-stump', to deliver balls between one and seven metres from the batter. Figure 1 shows how the bowling machine was moved 0.66 m either side of the middle stump to simulate right-arm bowlers over the wicket to right-handed batters and left-arm bowlers to left-handed batters. Batters stood with at least one foot in their crease.

<<Insert Figure 1 about here>>

Procedure

Participants were informed that they would be batting against a bowling machine and that their task was to hit all balls (no 'leaving'). They were informed that they could bat in as attacking or defensive style as they wanted but that they could not 'run down the wicket'. Participants completed a self-selected warm-up, including 10 warm-up shots from the bowling machine. Participants then took part in four attentional focus conditions: control, internal, proximal external, and distal external, using a randomised crossover design. In the control condition, no instruction was provided. Instructions provided in the internal focus condition were to “focus on the movement of your hands”. Instructions in the proximal external focus condition were to “focus on the movement of your bat” while in the distal external focus condition instructions were to “focus on the ball flight of your shot”. Wording and length of instructions were kept as similar as possible to control for the possibility of instruction length or complexity acting as a confounding variable (Wulf, 2013). Reminder prompts were given every eight deliveries.

Participants faced 30 deliveries per condition varying in velocity (65 ± 1 mph), line (manipulation from original target line), and swing bias (‘in’ and ‘out’ by up to one arbitrary unit on the bowling machine) to simulate regular seam bowling variability. The ball speed was selected following pilot testing, as it was deemed to create a realistic but challenging task. Deliveries considered ‘wide’ from a cricketer’s perspective, were retaken. Participants were given two to three minutes rest between conditions to reduce fatigue effects.

Data Analysis

Quality of bat-ball contacts was coded using an adapted form of Müller and Abernethy’s (2008) validated bat-ball contact classification (as previously employed to assess cricket batting effectiveness, e.g., Runswick et al., 2018). Bat-ball contacts were classified as follows: good - ball hits the blade, not handle/shoulder of the bat, and ball direction post-contact is consistent with bat motion; bad – ball hits the blade off-centre, and direction post-contact is inconsistent with bat motion; miss/edge – ball hits the edge/shoulder/handle of the bat or is missed. The number of ‘good’ bat-ball contacts determined successful performance. Failed bat-ball contact performance (number of ‘miss/edge’s) was also measured due to the inclusion of ‘bad’ bat-ball contacts. Making more ‘good’ bat-ball contacts would therefore not necessarily reduce the number of ‘miss/edge’ contacts. From a cricket perspective, ‘good’ bat-ball contacts represent run-scoring shots whilst ‘miss/edge’ contacts are potential wicket opportunities for the opposition. Analysing both success (‘good’ contacts) and failure (‘miss/edge’s) provides insight into run-scoring and wicket protection as separate skills that contribute to overall batting performance (Woolmer et al., 2008). The primary investigator analysed all data and determined intra-rater reliability six months later. Inter-rater reliability was determined between the primary investigator and an English Cricket Board Level 1 cricket coach. Intra- and inter-rater reliability were 93% and 89% respectively (see Thomas et al., 2015 for details on determining reliability).

Batting technique was analysed using Kinovea 0.8.15 (Kinovea open source, www.kinovea.com). Five straight drive shots were selected per condition per participant. Shots qualified for analysis when batters hit the ball back in the direction of the bowling machine with a vertically straight bat (confirmed by high front elbow) and their front foot pointing in the direction of the bowling machine. Balance also needed to be maintained throughout the shot. In each condition, the first five shots participants played that met these criteria were analysed. Straight drives were used because they are the most common shot in cricket, making it an important skill for batters (Stretch et al., 1998; Woolmer et al., 2008). Moreover, given the initial body orientation and subsequent movement to perform the shot being primarily in the sagittal plane, the 2D video analysis was most accurate for this shot type. To assess batting technique, two kinematic variables were taken at bat-ball contact. Knee flexion angle (°) provided a measure of the angle between the greater trochanter, lateral epicondyle of the femur, and the lateral malleolus (medial epicondyle and malleolus for left-handed batters).

Most participants wore shorts, enabling particularly accurate landmark locations for the ankle and knee whilst the hip location (greater trochanter) was also informed by the visual displacement of the thigh. Step length (m) provided a measure of the distance between the fifth metatarsal head of the back foot and the fifth metatarsal head of the front foot. These variables were investigated because cricketing literature emphasises the importance of batters making a large step closer to the pitch of the ball for effective bat-ball contact (Woolmer et al., 2008). Three participants displayed no qualifying shots for knee angle analysis (as the front leg was orientated out of plane of the camera) but did display shots suitable for step length analysis.

Statistical Analysis

To assess the effect of attentional focus instructions on successful and failed performance, two one-way repeated-measures ANOVAs were conducted, with the number of ‘good’ and ‘miss/edge’ contacts being analysed, respectively. To assess effects on batting technique, two further one-way repeated-measures ANOVAs were conducted, with step length and knee flexion angle acting as dependent kinematic variables. In the case of violations of sphericity, Greenhouse-Geisser corrected values are reported. In the case of multiple pairwise comparisons, Bonferroni corrections were applied to control for familywise error. Before running any analyses, data were tested for normality. Only two of 17 variables violated the Shapiro-Wilks test of normality (number of good contacts in the distal external condition, step length in the proximal external condition). As ANOVA is deemed robust to violations of normality (Blanca et al., 2017), we proceeded to run ANOVA. Partial eta-squared (η_p^2) values are reported for effect size of main effects, with Cohen’s *d* reported for comparisons between two means. Partial eta-squared values of 0.01, 0.06 and 0.14, and Cohen’s *d* values of 0.2, 0.5 and 0.8 are considered small, medium, and large effect sizes (Cohen, 1988).

Results

Batting Performance

Batting performance data are presented in Figures 2 and 3. The one-way repeated-measures ANOVA revealed a significant main effect of attentional focus on successful performance ($F_{3,\ 36}$ = 7.70, p < .01, η_p^2 = 0.39). Internal focus instructions resulted in significantly fewer (18.62 ± 3.07) good contacts than the control (21.15 ± 2.70, p < .05, d = 0.88) and distal external focus conditions (21.92 ± 2.02, p <.01, d = 1.19). No other significant differences were observed.

<<Insert Figure 2 about here>>

A significant main effect of attentional focus instructions on failed performance ($F_{3,\ 36}$ = 13.09, p < .01, η_p^2 = 0.52) was observed. The number of miss/edges in the internal focus condition (6.69 ± 1.84) was higher than in the control (4.76 ± 2.01, p < .01, d = 1.00), proximal external (4.46 ± 1.81, p < .01, d = 1.22), and distal external focus (3.85 ± 2.19, p < .01, d = 1.41) conditions. No other significant differences were observed.

<<Insert Figure 3 about here>>

Technique

Kinematic data are presented in Table 1. ANOVA revealed a significant main effect of attentional focus instructions on step length ($F_{1.746,\ 20.954}$ = 19.231, p < .01, η_p^2 = 0.616). Internal focus instructions resulted in shorter step lengths (0.82 ± 0.08 m) than the control (0.87 ± 0.09 m, p < .05, d = 0.65), proximal external focus (0.84 ± 0.07 m, p < .05, d = 0.34) and distal external focus conditions (0.89 ± 0.09 m, p < .05, d = 0.86). Step length was also shorter in the proximal than the distal external focus condition (p < .05, d = 0.58). No other between-condition differences were observed.

<<Insert Table 1 about here>>

ANOVA revealed a significant main effect of attentional focus instructions on knee flexion angle ($F_{3, 27}$ = 4.72, η_p^2 = 0.34, p < .01). Pairwise comparisons, however, revealed no significant differences between conditions.

Discussion

The aim of this study was to investigate the effect of attentional focus instructions on skilled cricket batters' batting performance and technique, to ascertain whether attentional focus effects observed in research using closed-skill tasks are evident in open-skill tasks. Participants batted against deliveries from a cricket bowling machine whilst receiving internal, proximal external or distal external focus instructions, and in a control condition with no instructions. We hypothesised that a distal external focus would yield better batting performance than the internal and proximal external focus conditions, but that participants would also perform better when adopting a proximal external focus than focusing internally (Bell & Hardy, 2009; Castaneda & Gray, 2007). We further hypothesised that step lengths would be shorter and knee angles more extended when focusing internally as doing so is associated with longer reaction times and greater muscular co-contractions and stiffness (Lohse et al., 2010; Vance et al., 2004).

Consistent with our primary hypothesis, when instructed to adopt a distal external focus, skilled cricket batters made more successful bat-ball contacts than when focusing internally. This finding is consistent with theories of motor control that suggest an external focus promotes more automatic movement production than focusing internally (Conscious Processing Hypothesis, Poolton et al., 2006; Constrained Action Hypothesis, Wulf et al., 2001). Compared with focusing internally, researchers have demonstrated that an external focus can lead to reduced cognitive demands and faster reaction times (Sherwood et al., 2020; Wulf et al., 2001). However, focusing externally can also enhance movement technique and decrease muscular stiffness (Hitchcock & Sherwood, 2018; Lohse et al., 2010). In this study, an internal focus resulted in shorter step lengths than an external focus, with a distal external focus yielding the longest step length. While our interpretations require further investigation, we tentatively suggest that instructions directing attention towards the production of the movement may lead to shorter step lengths as a result of longer reaction times, increased muscle co-contractions and stiffness. Moreover, although our internal focus instructions related to the movement of the hands on the handle of the bat, the instructions appear to have negatively affected lower body movement. This finding provides support for the suggestion that focusing internally negatively affects movement efficiency on a more general scale (e.g., Lohse et al., 2010; Vance et al., 2004).

The control condition yielded largely the same pattern of findings as the distal external focus condition. Studies involving skilled performers have shown similar (or greater) performance benefits when provided with no instruction as with external focus instructions (e.g., Bezodis et al., 2017; Stoate & Wulf, 2011). Participants in the current study were skilled cricket batters, for whom batting is an automatic skill. Focusing on the ball flight is therefore unlikely to lead to greater automaticity than normally experienced without instruction. However, while the control condition led to more successful bat-ball contacts than the internal focus condition, this difference was not evident between the proximal external and internal focus conditions. While the general lack of differences between these conditions does not support our hypothesis, the findings do reflect those of Bezodis et al. (2017), who demonstrated that experienced athletes who adopted a proximal external focus displayed longer sprint times and more vertically oriented ground reaction forces than when provided with no instruction. Bezodis et al. (2017) suggested that external focus effects may only be evident in skilled performers should the focus be environmental rather than skill-focused, which reflects the better performance and technique in distal external compared to internal focus conditions in this study (see also Castaneda & Gray, 2007). A potential alternative explanation for better performance when receiving distal compared with proximal external focus instructions is that, when focusing on the movement of the bat, although the focus is on the action effect, this effect is nevertheless closely associated with the timing of the production of the skill, i.e., participants focused on the movement of the bat *during* the swing. In contrast, when focusing on the flight of the shot, attention is more clearly directed to the action effect *after* the shot, which may facilitate more automatic movement production. An interesting line of research may be to investigate how focusing on proximal action effects at different time points in skill production (e.g., during the backswing, at contact, during the follow through) affects performance.

The largest effects were observed for failed bat-ball contact performance, with an internal focus yielding more ‘miss/edge’ contacts than the control, proximal and distal external focus conditions. In contrast, effect sizes, whilst still large, were reduced for successful performance, with only the control and distal external focus conditions yielding more good bat-ball contacts than when focusing internally. While further research is needed to investigate this, it appears that the potency of attentional focus effects may vary between skills within sports. Specifically, these findings suggest that for cricket batting, an internal focus appears to reduce wicket protection ability more than run scoring ability. While the cause of this difference cannot be determined here, it may be that focusing internally when playing an attacking shot results in at least a partial shift in focus towards external variables such as post-contact ball flight, due to the strategic intention of the shot (e.g., to hit the ball a specific distance/height/direction). Conversely, for defensive shots, as the strategic intention is merely to block the ball, an internal focus may be maintained throughout the shot. These findings provide an initial insight into how different skills within sports may benefit to varying degrees from attentional focus instructions and provides an additional avenue for further research because researchers have previously tended to examine attentional focus effects in isolated skills. While differences in attentional focus effects have been demonstrated across different skills in the same sport (e.g., pitching and putting in golf; Bell & Hardy, 2009; Kearney, 2015), a more systematic approach in which multiple skills are investigated in single studies is needed.

Overall, our findings generally reflect research in closed-skill tasks demonstrating performance and movement benefits of a distal external focus over an internal focus (Bell & Hardy, 2009), but also that, in skilled performers, no instruction can be as effective as focusing externally (Bezodis et al., 2017; Stoate & Wulf, 2011). Taken together, from a practical perspective, our findings suggest that to optimise performance in skilled cricket batters, if instructions are deemed necessary, they should promote a distal external focus (e.g., on the ball flight).

This study has some limitations, one being that no formal manipulation check was conducted to assess if participants focused on what was instructed. Although the pattern of findings generally reflecting previous research (e.g., Bell & Hardy, 2009; Castaneda & Gray, 2007) would suggest the instructions were heeded, this cannot be stated with certainty. Moreover, verifying what participants focused on in the control condition would have been beneficial to advance theory and application. For example, it is conceivable that the nature of the task (striking a ball) inherently led to an external focus of attention being adopted, which would explain why little difference between the control and distal external focus condition was observed (see also Abdollahipour et al., 2022). Wang et al. (2021) provided preliminary evidence of meshed motor control in skilled golfers performing a putting task. Performance and neuromotor processes (measured via EEG) were compared across internal focus, external focus, and control conditions. In the control condition, without instruction, the EEG data reflected the more automatic control process of the external focus condition early in shot preparation but suggested a switch to processes more closely resembling an internal focus (and conscious control of the skill) immediately prior to making the putt. Orr et al. (2021) have also observed that skilled golfers appear to employ a variety of attentional foci in training and competition. It therefore seems pertinent that researchers investigate the attentional foci naturally employed by athletes more fully, across different sports and across skills within sports.

A further limitation was the small number of trials for which the kinematic data could be analysed. Because participants were required to bat under four attentional focus conditions, the number of trials was limited to reduce the likelihood of overuse injuries occurring (Stretch, 2007). Nevertheless, combined with the relatively small number of participants completing the task across four experimental conditions, we suggest that researchers and practitioners approach these findings with a degree of caution and recommend that further research be conducted to confirm the findings of our kinematic analysis.

In conclusion, this novel investigation offers support for a distal external focus of attention enhancing performance compared with focusing internally during skilled performance of an open skill (Poolton et al., 2006; Wulf et al., 2001). Specifically, skilled cricket batters' batting performance was worse and step lengths shorter when focusing internally than in distal external or control conditions. We also demonstrated that attentional focus effects may vary based on the type of shot played, with participants' ability to protect the wicket more negatively affected by an internal focus than their ability to score runs. Future research should aim to determine how different types of skills within specific sports are affected by attentional focus instructions.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

References

Abdollahipour, R., Land, W. M., Valtr, L., Banátová, K., & Janura, M. (2022). External focus facilitates cognitive stability and promotes motor performance of an interceptive task in children. *International Journal of Sport and Exercise Psychology*, 1-17.

Becker, K. A., & Fairbrother, J. T. (2019). The use of multiple externally directed attentional focus cues facilitates motor learning. *International Journal of Sports Science & Coaching*, *14*, 651-657.

Beilock, S. L., Carr, T. H., MacMahon, C., & Starkes, J. L. (2002). When paying attention becomes counterproductive: impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied*, *8*, 6-16.

Bell, J. J., & Hardy, J. (2009). Effects of attentional focus on skilled performance in golf. *Journal of Applied Sport Psychology*, *21*, 163-177.

Bezodis, N. E., North, J. S., & Razavet, J. L. (2017). Alterations to the orientation of the ground reaction force vector affect sprint acceleration performance in team sports athletes. *Journal of Sports Sciences*, *35*, 1817-1824.

Blanca Mena, M. J., Alarcón Postigo, R., Arnau Gras, J., Bono Cabré, R., & Bendayan, R. (2017). Non-normal data: Is ANOVA still a valid option?. *Psicothema*, *29*, 552-557.

Castaneda, B., & Gray, R. (2007). Effects of focus of attention on baseball batting performance in players of differing skill levels. *Journal of Sport and Exercise Psychology*, *29*, 60-77.

Chua, L. K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. *Psychological Bulletin*, *147*, 618.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* Lawrence Erlbaum Associates. Hillsdale: NJ.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191.

Ford, P. R., Yates, I., & Williams, A. M. (2010). An analysis of practice activities and instructional behaviours used by youth soccer coaches during practice: Exploring the link between science and application. *Journal of Sports Sciences*, *28*, 483-495.

Gray, R. (2004). Attending to the execution of a complex sensorimotor skill: expertise differences, choking, and slumps. *Journal of Experimental Psychology: Applied*, *10*, 42-54.

Gray, R. (2011). Links between attention, performance pressure, and movement in skilled motor action. *Current Directions in Psychological Science*, *20*, 301-306.

Halperin, I., Chapman, D. W., Martin, D. T., Abbiss, C., & Wulf, G. (2016). Coaching cues in amateur boxing: an analysis of ringside feedback provided between rounds of competition. *Psychology of Sport and Exercise*, *25*, 44-50.

Hitchcock, D. R., & Sherwood, D. E. (2018). Effects of changing the focus of attention on accuracy, acceleration, and electromyography in dart throwing. *International Journal of Exercise Science*, *11*, 1120-1135.

Kearney, P. E. (2015). A distal focus of attention leads to superior performance on a golf putting task. *International Journal of Sport and Exercise Psychology*, *13*, 371-381.

Lohse, K. R. (2012). The influence of attention on learning and performance: Pre-movement time and accuracy in an isometric force production task. *Human Movement Science*, *31*, 12-25.

Lohse, K. R., Sherwood, D. E., & Healy, A. F. (2010). How changing the focus of attention affects performance, kinematics, and electromyography in dart throwing. *Human Movement Science*, *29*, 542-555.

Maxwell, J. P., & Masters, R. S. W. (2002). External versus internal focus instructions: Is the learner paying attention?. *International Journal of Applied Sports Sciences*, *14,* 70-88.

Masters, R. S. & Maxwell, J. (2008). The theory of reinvestment. *International Review of Sport and Exercise Psychology*, *1*, 160-183.

McNevin, N. H., Shea, C. H., & Wulf, G. (2003). Increasing the distance of an external focus of attention enhances learning. *Psychological Research*, *67*, 22-29.

Müller, S., & Abernethy, B. (2008). Validity and reliability of a simple categorical tool for the assessment of interceptive skill. *Journal of Science and Medicine in Sport*, *11*, 549-552.

Orr, S., Cruickshank, A., & Carson, H. J. (in press). From the lesson tee to the course: A naturalistic investigation of attentional focus in elite golf. *The Sport Psychologist*. *35*, 305-319.

Partington, M., & Cushion, C. (2013). An investigation of the practice activities and coaching behaviors of professional top-level youth soccer coaches. *Scandinavian Journal of Medicine & Science in Sports*, *23*, 374-382.

Poolton, J. M., Maxwell, J. P., Masters, R. S. W., & Raab, M. (2006). Benefits of an external focus of attention: Common coding or conscious processing? *Journal of Sports Sciences*, *24*, 89-99.

Porter, J. M., Anton, P. M., Wikoff, N. M., & Ostrowski, J. B. (2013). Instructing skilled athletes to focus their attention externally at greater distances enhances jumping performance. *The Journal of Strength & Conditioning Research*, *27*, 2073-2078.

Runswick, O. R., Roca, A., Williams, A. M., McRobert, A. P., & North, J. S. (2018). The temporal integration of information during anticipation. *Psychology of Sport and Exercise*, *37*, 100-108.

Sherwood, D. E., Lohse, K. R., & Healy, A. F. (2020). The effect of an external and internal focus of attention on dual-task performance. *Journal of Experimental Psychology: Human Perception and Performance*, *46*, 91.

Singh, H., & Wulf, G. (2020). The distance effect and level of expertise: Is the optimal external focus different for low-skilled and high-skilled performers?. *Human Movement Science*, *73*, 102663.

Stoate, I., & Wulf, G. (2011). Does the attentional focus adopted by swimmers affect their performance? *International Journal of Sports Science & Coaching*, *6*, 99-108.

Stretch, R., Buys, F., Toit, E. D., & Viljoen, G. (1998). Kinematics and kinetics of the drive off the front foot in cricket batting. *Journal of Sports Sciences*, 16, 711-720.

Stretch, R. A. (2007). A review of cricket injuries and the effectiveness of strategies to prevent cricket injuries at all levels. *South African Journal of Sports Medicine*, 19, 129-132.

Stuelcken, M. C., Portus, M. R., & Mason, B. R. (2005). Off-side front foot drives in men's high performance cricket. *Sports Biomechanics*, *4*, 17-36.

Thomas, J. R., Nelson, J. K., Silverman, S. J. (2015). *Research methods in physical activity* (7th ed.). Human Kinetics.

Vance, J., Wulf, G., Töllner, T., McNevin, N., & Mercer, J. (2004). EMG activity as a function of the performer's focus of attention. *Journal of Motor Behavior*, *36*, 450-459.

Wang, K. P., Frank, C., Tsai, Y. Y., Lin, K. H., Chen, T. T., Cheng, M. Y., ... & Schack, T. (2021). Superior performance in skilled golfers characterized by dynamic neuromotor processes related to attentional focus. *Frontiers in Psychology*, *12*, 337.

Woolmer, B., Noakes, T., Moffett, H., & Lewis, F. (2008). *Bob Woolmer's art and science of cricket*. London: New Holland.

Wulf, G. (2013). Attentional focus and motor learning: a review of 15 years. *International Review of Sport and Exercise Psychology*, *6*, 77-104.

Wulf, G., McNevin, N. H., Fuchs, T., Ritter, F., & Toole, T. (2000). Attentional focus in complex skill learning. *Research Quarterly for Exercise and Sport*, *71*, 229-239.

Wulf, G., McNevin, N., & Shea, C. H. (2001). The automaticity of complex motor skill learning as a function of attentional focus. *The Quarterly Journal of Experimental Psychology Section A*, 54, 1143-1154.

Tables

Table 1. Mean (*SD*) step length and knee flexion angle across attentional focus conditions. * and † denote significantly larger step lengths observed in these conditions compared with the internal and proximal external focus conditions, respectively ($p < .05$)

Kinematic Measure	Control	Internal	Proximal External	Distal External
Step length (m)	0.87 (0.09)*	0.82 (0.08)	0.84 (0.07)*	0.89 (0.09)* †
Knee flexion angle (°)	136.93 (9.04)	144.61 (10.49)	141.41 (7.02)	135.31 (6.14)

Figures

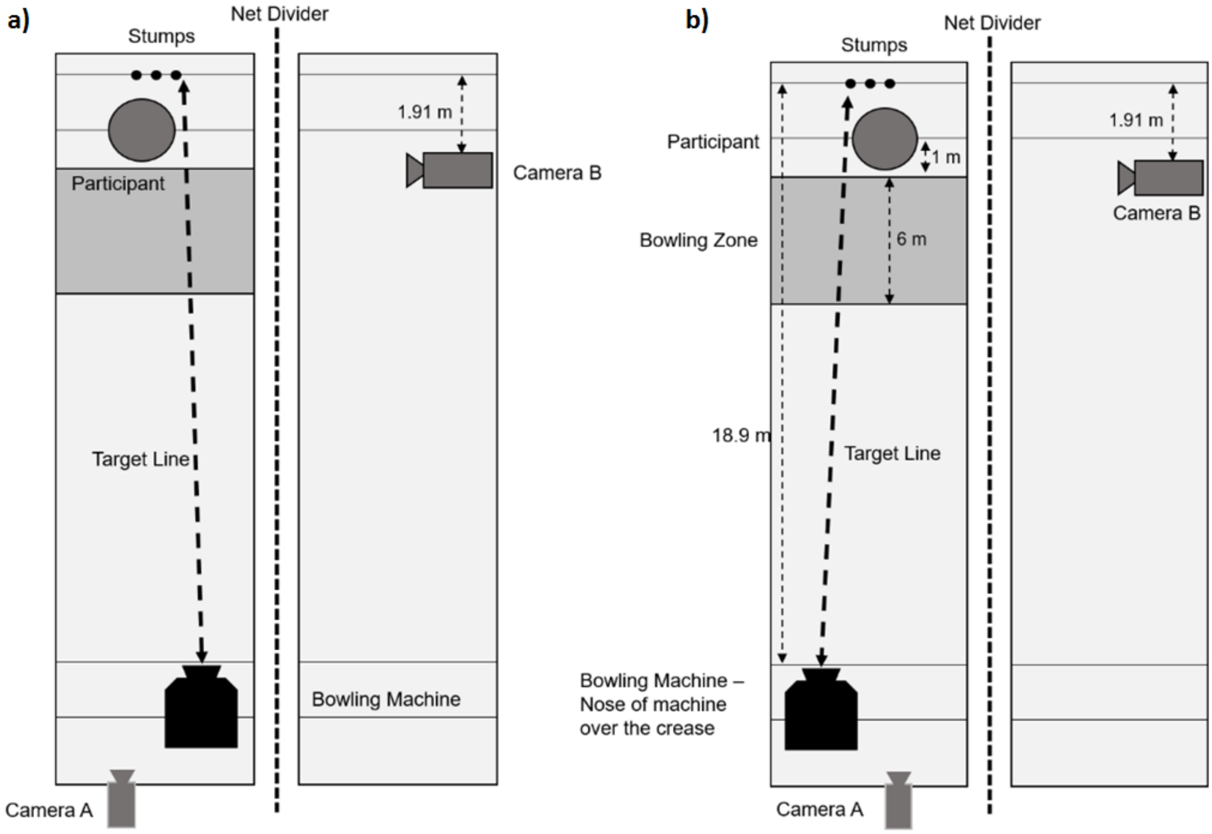

Figure 1. Set-up of apparatus for a left-handed (a) and a right-handed (b) batter respectively (figure not to scale).

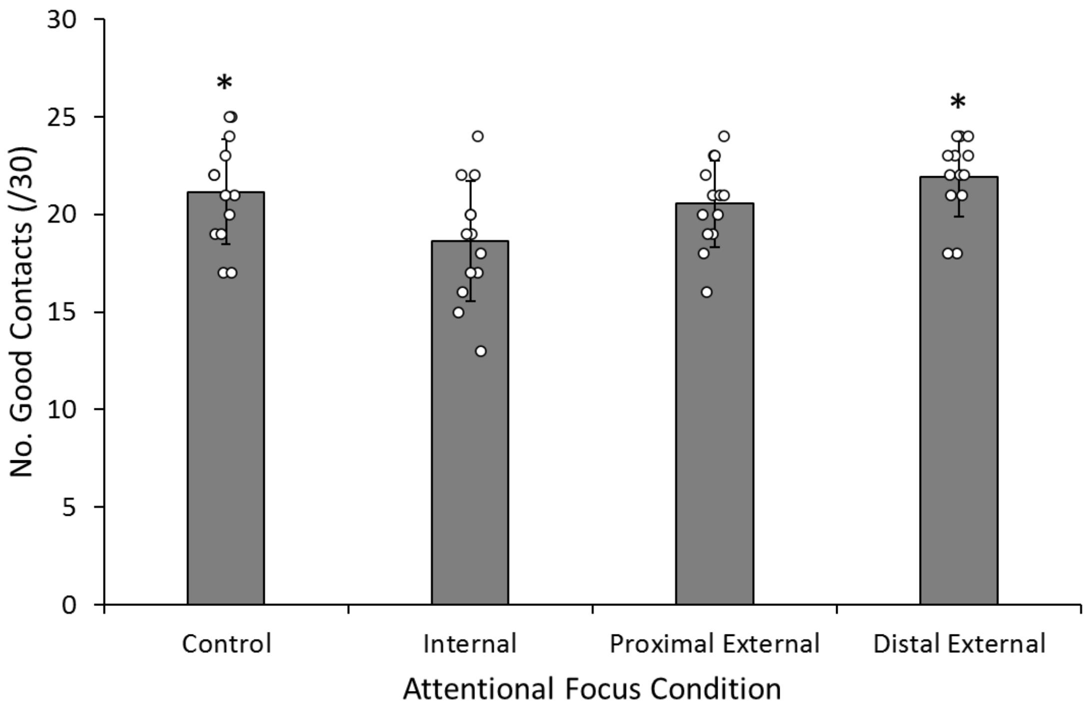

Figure 2. Mean (SD) number of ‘good’ bat-ball contacts across attentional focus conditions. *Significantly different from internal focus (p < .05).

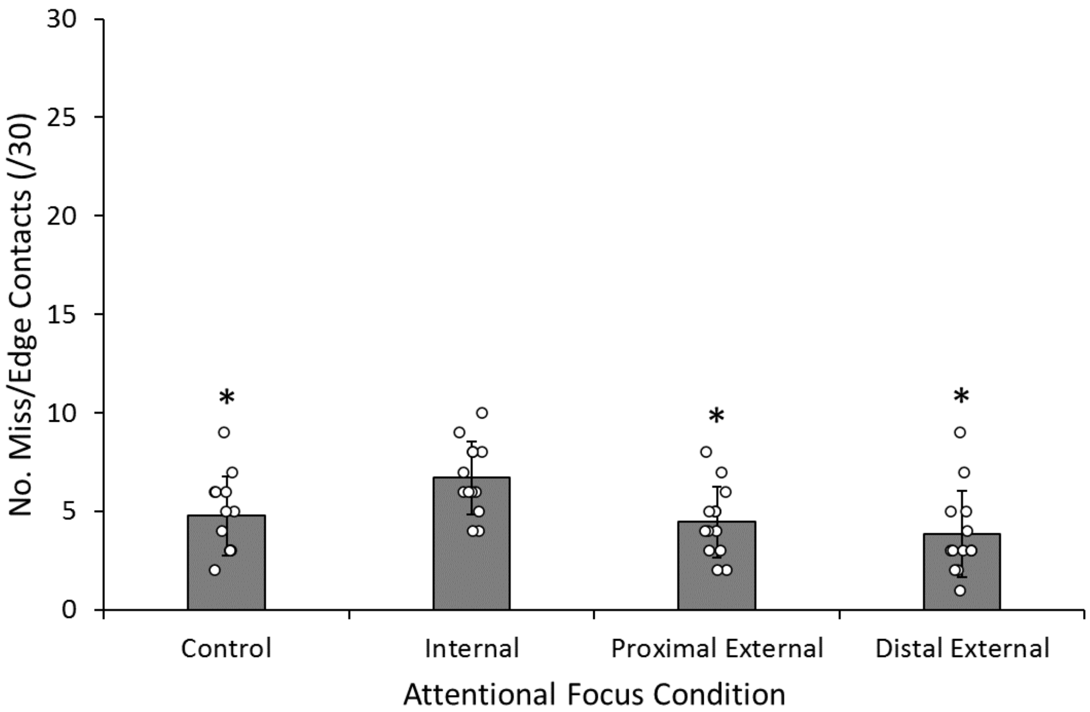

Figure 3. Mean (SD) number of 'miss/edge' contacts across attentional focus conditions.

*Significantly different from internal focus (p < .05).